Cleaner Technology and Energy Efficiency

Structuring a Competitive Advantage

April 5, 2007

LENOX American Saw

Energy Auditing

Compressed Air Systems

Energy Audits Cover Many Areas

Building Envelop

Facility Utilities:

- Lighting, Office or Factory
- Electrical equipment/distribution
- Heating/Cooling Systems
- **Compressed Air, Generation and Application**

Energy Audits Are Performed By:

- Utilities
- ESCOs (Energy Service Companies)
- Equipment Providers & Installers
- Company In House Personal
- Independent Consultants

Today Energy Audits are being Required by:

- Large Corporations with Central Energy Management
- Utilities for DSM (Demand Side Management) Projects
  - Supports the Utility DSM Payments
- To qualify for many Energy Incentives
  - State and/or Federal

Payment for Energy Audits can be:

- 100% by Company being Audited
- 50/50 with the Utility
- 100% by the Utility
- 50/50 with an ESCO
- 100% by an ESCO

Etc.

Cost:

Audits can Range from Tens of Thousands

Large Facilities/Total Scope

To as little as $500

Small Dedicated Projects

On Average Audits should be Under $10,000

Audits Need To Provide:

1. A Goal
2. A Picture of the Existing Condition
3. Measurement Tools ($, kwh, cfm, R, etc) for the;
    1. Current Situation
    2. Changes
    3. Future

Audits Need To :

1. Identify
   - Good Situations
   - Bad Situations
   - Opportunities with Best-Least Returns
2. Differences Between Behavioral & Equipment/Application
3. They Must Meet the Requirements of the Controlling Agency

And as Important as Anything:

In a Manufacturing Situation the Auditor Must Understand the Particular Energy Application for that Industry and Its Interaction Into the Facility as a Whole.

This becomes very important in developing recommendations and prioritizing changes.

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Newell Rubbermaid

American Saw & Mfg. Co.

East Longmeadow, MA

A Compressed Air System Audit
by
Air Compressor Engineering Co., Inc.

Performed by Gary H. Shafer

February 1996

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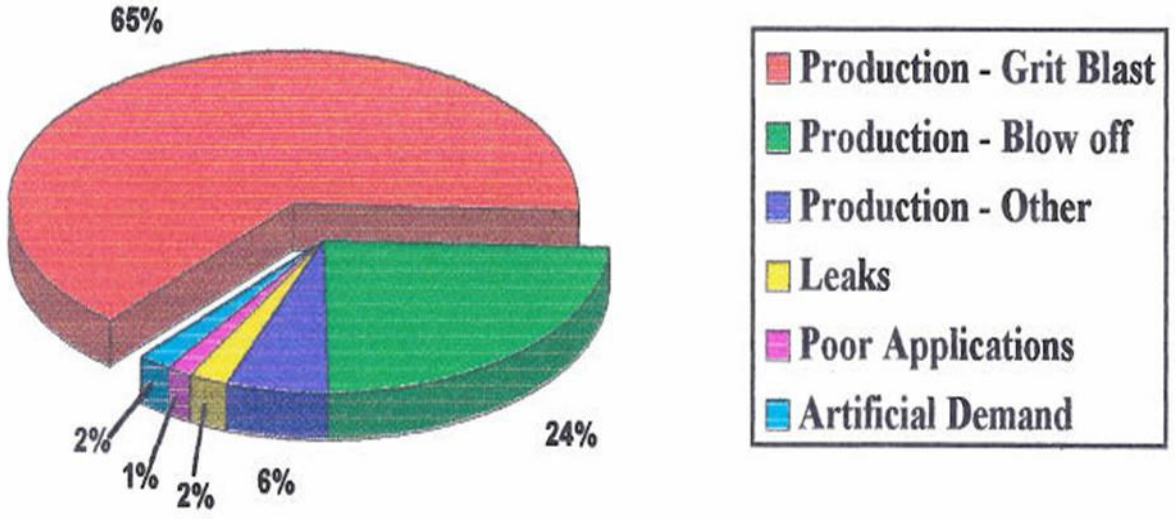
Survey Overview

Compressed air is a costly utility but rarely treated so. In most facilities it is used as if it were a free and unlimited resource. The primary goal of these audits is to assign a cost to the production of compressed air as a utility in your plant, and the subsequent costs associated with its utilization in production. With this information at hand you will have the ability to evaluate uses (and misuses) of compressed air from a monetary point of view.

The following pie chart shows the components of (full production) demand in your plant:



Ideally, production should occupy the majority of this chart which indicates that minimizing waste in your system has limited potential for returns in energy savings. Leaks appear to be an easy target for reducing waste since many of your larger leaks were tagged, but a leak that is repaired reduces the overall plant demand causing the average system pressure to rise. This forces other leaks and unregulated open blow off to expel more air at the higher pressure, a net gain of zero.

Demand Side Issues

- Production Use
  - True requirement of compressed Air Applications
- Non-Production Uses
  - Leaks
  - Artificial Demand
    - Over pressuring end users
    - Varying System Pressure
    - Point of use high differential pressure
    - Air Receivers/Point of Use Storage

Demand Side Issues cont

- Poor Applications
  - Air motors
  - Vacuum Transducers
  - Pressure Boosters vs. Dedicated Supply
- Grit Blasting-Working Pressure

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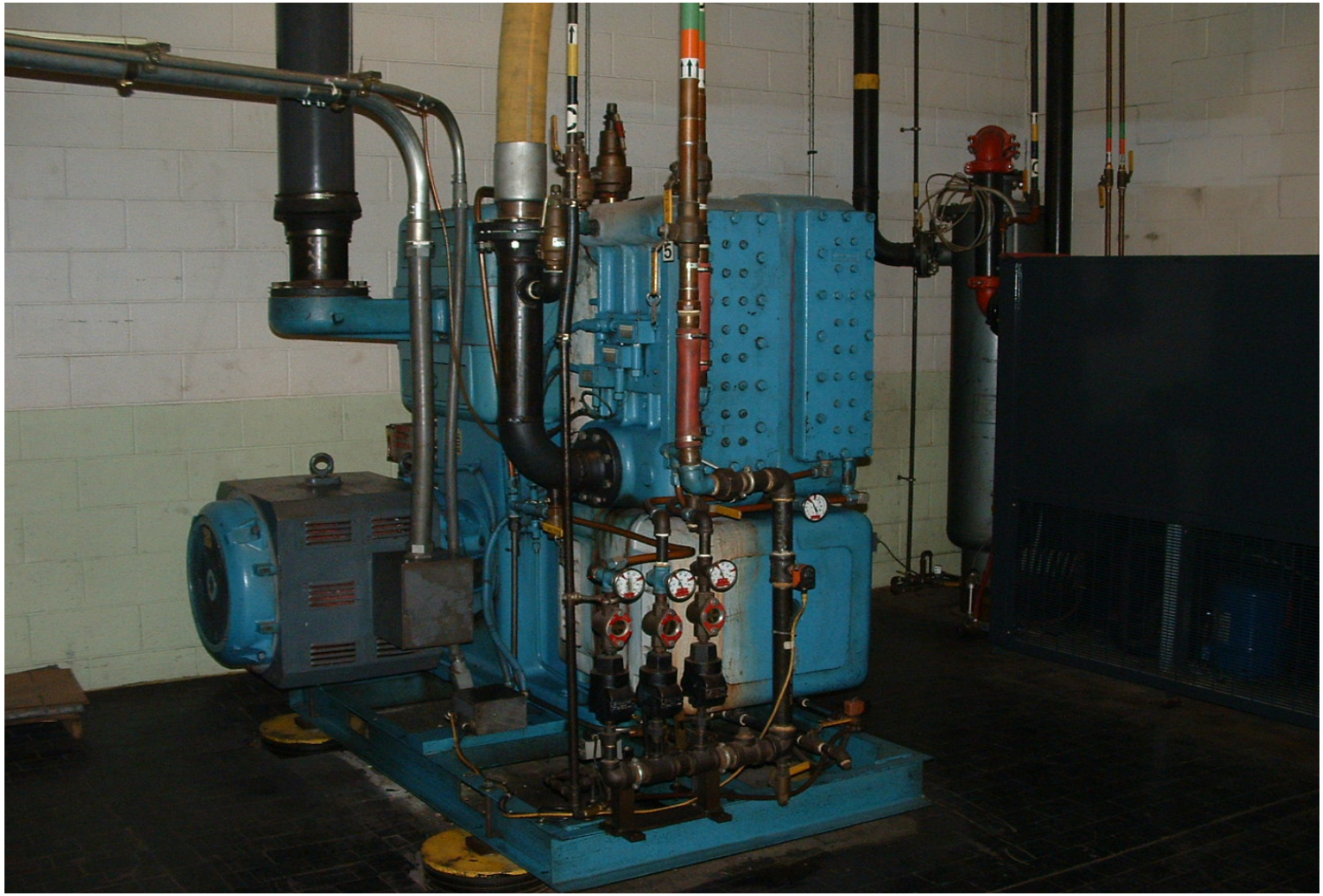
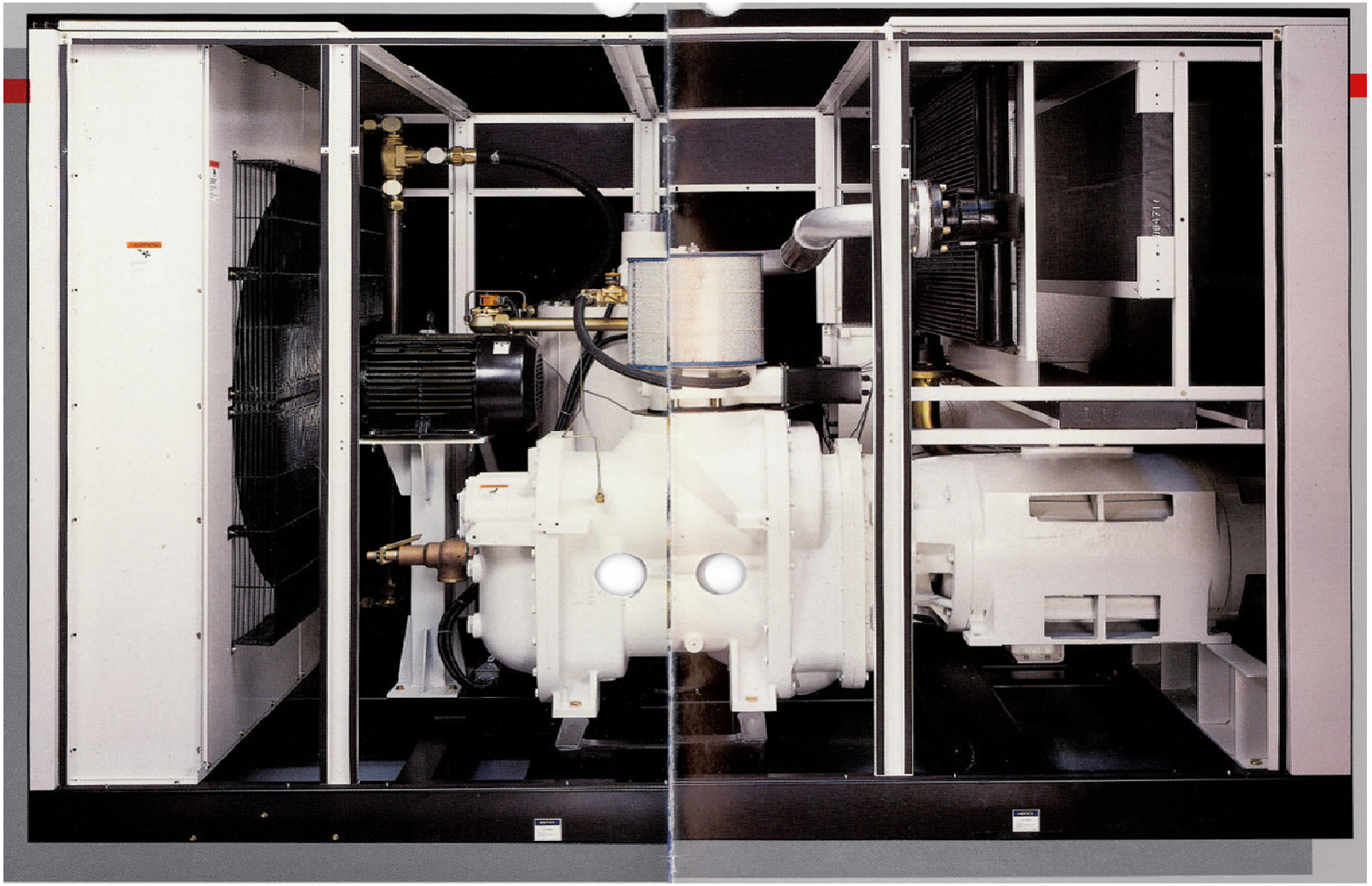
Supply Side 1996

8ea Compressors all running on Local Controls

5ea 150 hp 2 Stage Receipt	4125 scfm
1ea 125 hp 2 Stage Receipt	650 scfm
1ea 100 hp 2 Stage Receipt	500 scfm
1ea 200 hp 2 Stage Rotary Screw	1000 scfm
1175 hp	5375 scfm





- Local controls separated by 2 psig
- All units floating on Production System
- Central Storage Supply Needed
  - Had only 2000 gals of storage capacity total
- Demand expander to production system needed
- Major Opportunity to minimize false Demand and stabilize System Pressure

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Plan of Action

Supply Side

Based on the previous section's demand profile it is obvious that your compressed air system offers opportunity for savings. Central to achieving these savings is the installation of central controls and properly sized control storage. Presently the compressors are added/deleted manually, a practice that lends itself to operating too much power. The automation panel should be programmable and have the ability to stop and start compressors around a target pressure level.

- In 1998 another 200 hp 2 Stage Rotary Screw unit was added and the 100 hp 2 stage Receipt was eliminated.
- No storage was added.
- The Local Controls were set such that the 200 hp Rotary Screw machines were base loaded.
- All other system issues still existed.

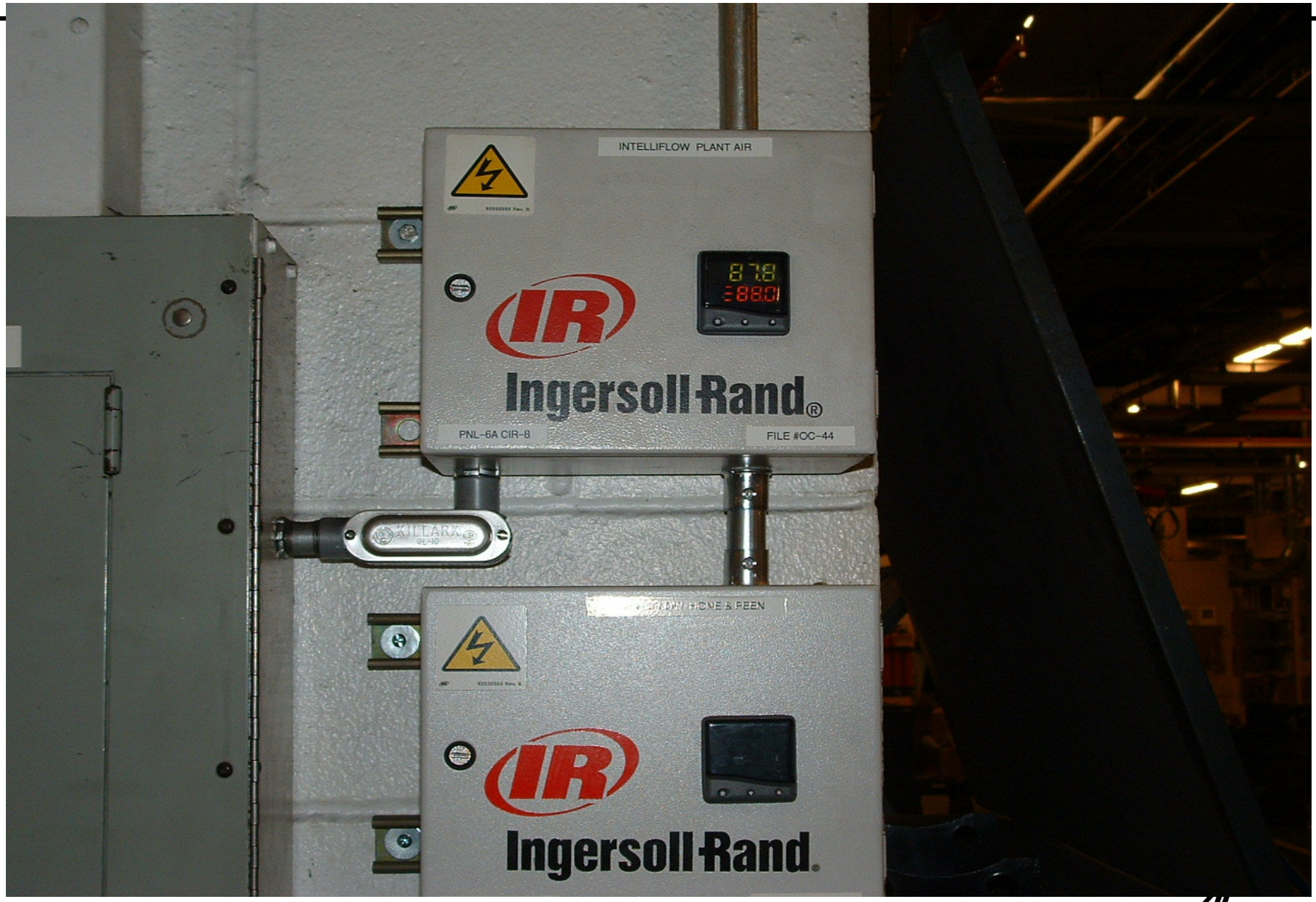
- In 1999-2002 a total plant re-layout took place
- At this time we added point of use storage to:
  - Compressed Air Blow Down for Pressure Filters
    - 3 ea 10 hp compressors with 200 psig 660 gal storage
  - Compressed Air Supply for Clamshell Blasters
    - 3 ea system pressure storage vessels, 1ea 400 & 2ea 600 gal storage

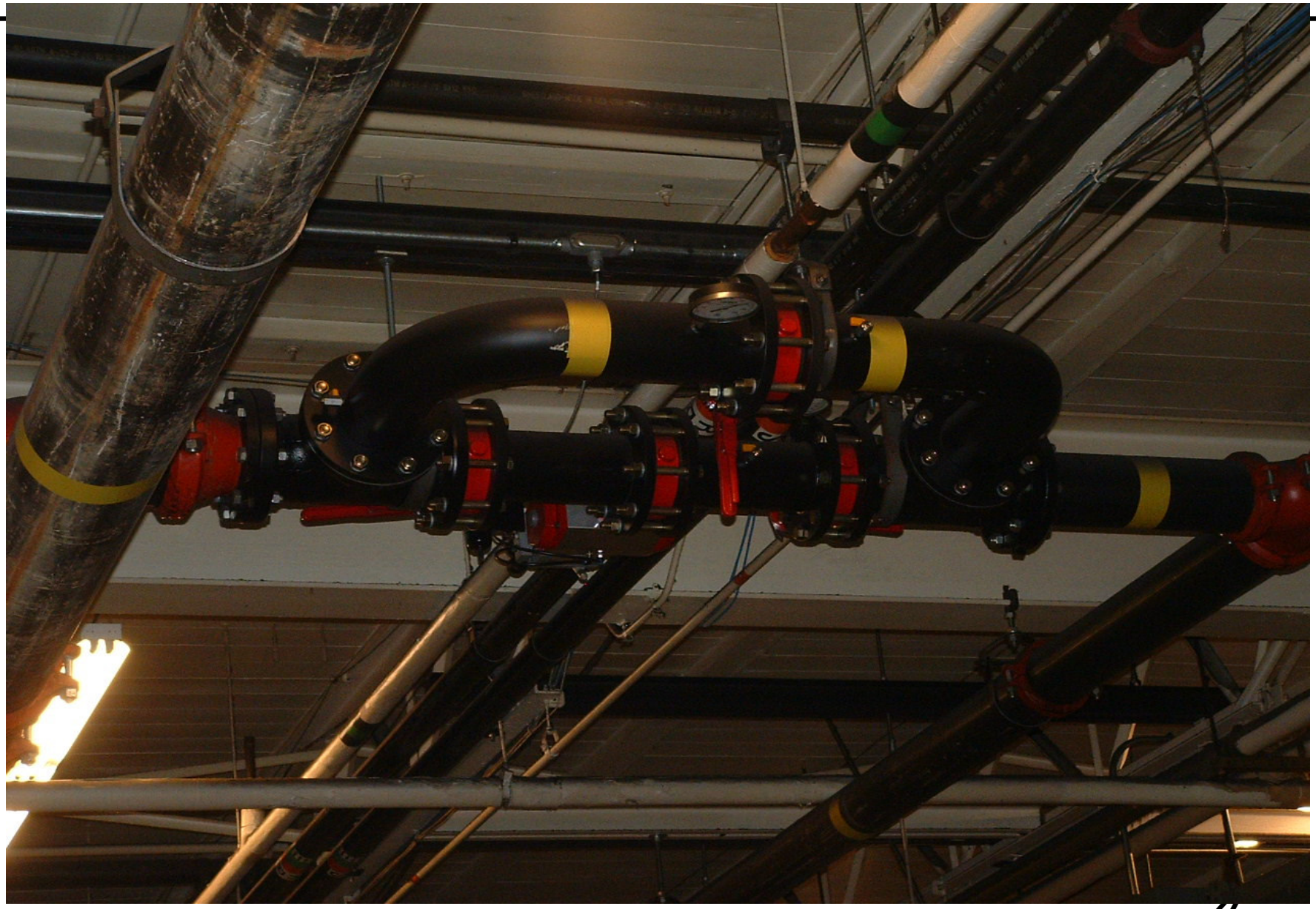
Production system began to stabilize and much compressor short cycling was eliminated avoiding the purchase of a 200 hp unit. Estimated $40k savings and $100k avoidance.


COMPRESSED
AIR
OPERATING
#3
6

- In 2003 began a systematic up grade of air compressors
- 150 hp units aging and costly to maintain.
- Took the opportunity for a major system up grade in December 2003
  - 2 ea new Nirvana vfd 2 stage Rotary Screw units.
  - 3000 gals of additional storage
  - Separated storage from production system with a Demand Controller
  - Installed an 8ea compressor controller on the Storage System


COMPRESSED AIR
AIR RECEIVER
OPERATING PRESSURE 110 LBS
GALLONS 1550
10
COMPRESSED AIR
AIR RECEIVER
OPERATING PRESSURE 110 LBS
GALLONS 1550
9


INTELLIFLOW PLANT AIR
Ingersoll-Rand
PNL-6A CIR-8
FILE #OC-44
Ingersoll-Rand



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Project Breakout

1. 2ea vfd units replaced 2ea aging receipts.
2. Both vfd units, storage system, storage system controller and plant demand controller supported by DSM Rebate
3. Cost Breakout

Total Cost	$303,000
DSM Rebate	$130,000
Net Cost	$173,000

Annual Savings in 2003 was $70,000+/year

All the benefits and savings depicted in the Compressed Air Audit have been Realized for the items that have been completed.

Again in 2006 a growth and replacement project took place.

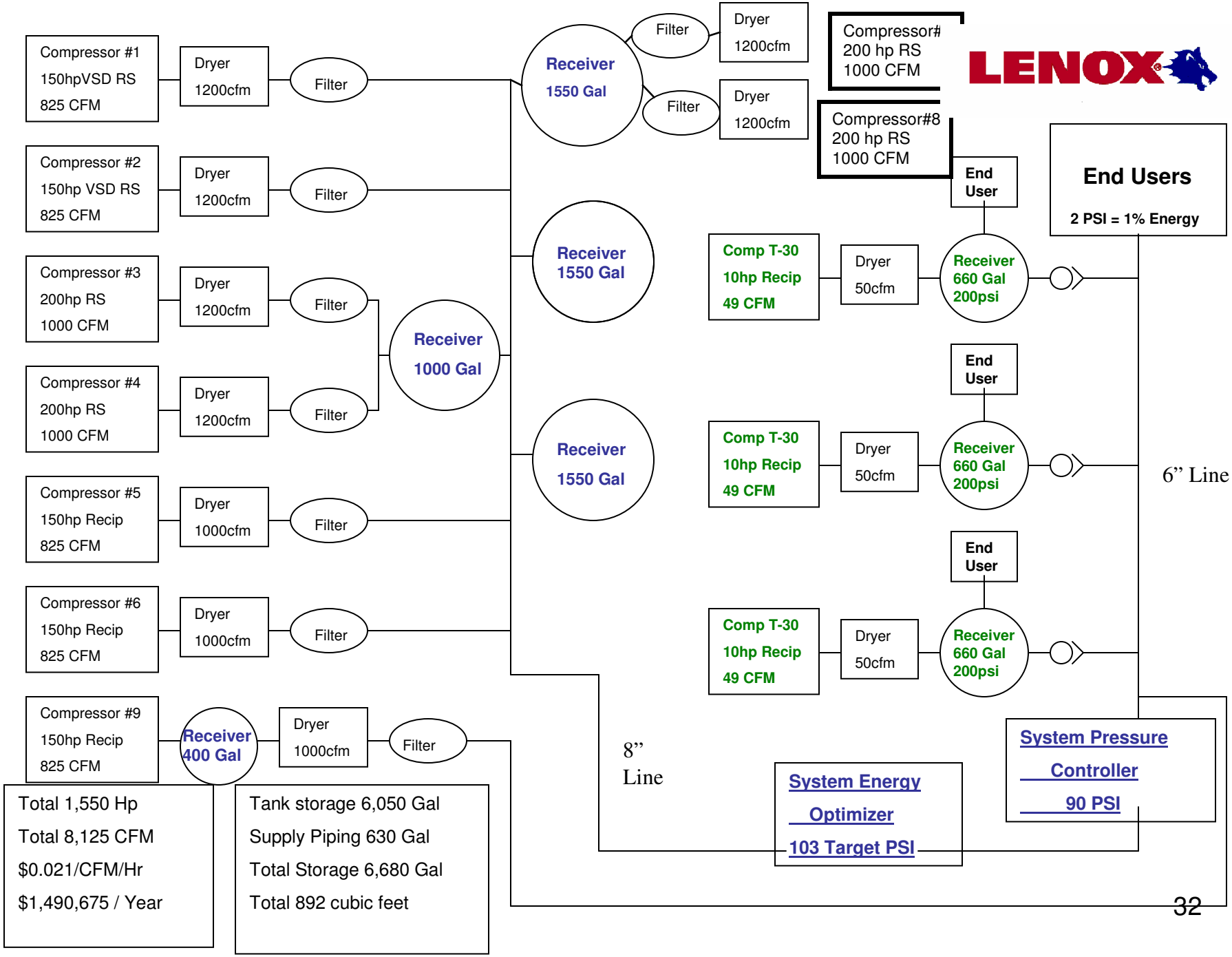
Current Compressed Air System

1550 HP of Compressed Air

- **4ea 200 HP two stage Rotary Screw Machine**
- **2ea 150 HP two stage Rotary Screw Variable Drive Units**
- **3ea 150 HP two stage Recip units**

Approximately 8000 scfm capacity.

Annual operational cost are close to $1,000,000. Almost 20% of the total plant Electrical Cost.


Compressor #1
150hpVSD RS
825 CFM
Dryer
1200cfm
Filter
Compressor #2
150hp VSD RS
825 CFM
Dryer
1200cfm
Filter
Compressor #3
200hp RS
1000 CFM
Dryer
1200cfm
Filter
Compressor #4
200hp RS
1000 CFM
Dryer
1200cfm
Filter
Receiver
1000 Gal
Compressor #5
150hp Recip
825 CFM
Dryer
1000cfm
Filter
Compressor #6
150hp Recip
825 CFM
Dryer
1000cfm
Filter
Compressor #9
150hp Recip
825 CFM
Receiver
400 Gal
Dryer
1000cfm
Filter
Total 1,550 Hp
Total 8,125 CFM
$0.021/CFM/Hr
$1,490,675 / Year
Tank storage 6,050 Gal
Supply Piping 630 Gal
Total Storage 6,680 Gal
Total 892 cubic feet
Receiver
1550 Gal
Filter
Dryer
1200cfm
Filter
Dryer
1200cfm
Receiver
1550 Gal
Receiver
1550 Gal
8"
Line
Compressor#
200 hp RS
1000 CFM
Compressor#8
200 hp RS
1000 CFM
LENOX
End Users
2 PSI = 1% Energy
End
User
Comp T-30
10hp Recip
49 CFM
Dryer
50cfm
Receiver
660 Gal
200psi
End
User
Comp T-30
10hp Recip
49 CFM
Dryer
50cfm
Receiver
660 Gal
200psi
End
User
Comp T-30
10hp Recip
49 CFM
Dryer
50cfm
Receiver
660 Gal
200psi
6" Line
System Energy
Optimizer
103 Target PSI
System Pressure
Controller
90 PSI

Reasons for Last Two 200 HP Machines

1. Increased air requirements for new Hone & Peen Line
2. Planed replacement of current old LLE Receipts

COMPRESSOR HEAT RECOVERY PROJECT

Heat Recovery has turned a Spend/Spend Project into a return on Investment Project.

At full load each 200 HP compressor rejects over 600,000 BTUs/HR

With the two units the 1.2 million BTUs/HR will provide approximately 50% of the heat load of Blding #9

Estimated Negative Air Reduction of 5,000 to 15,000 CFM.

The Expected Natural Gas Usage Reduction of 7077 Dth at an all in cost of $13.30/Dth equals over $94,000 annually savings.

Heat Recovery System

Automatic PLC Damper Controls for both Inlet and Exiting Comp Cooling Air

Inlet Cooling Air

Set at 40 to 45 Deg F- Full outside to a blend of in/out to full inside air.

Temps bellow freezing to be avoided.

Normal Cooling Air Temperature rise is 40 Deg F @ 15,000 CFM

Outlet Cooling Air

Set at 82 to 84 Deg F – Full discharge to Blding to a blend of in/out to full outside discharge.

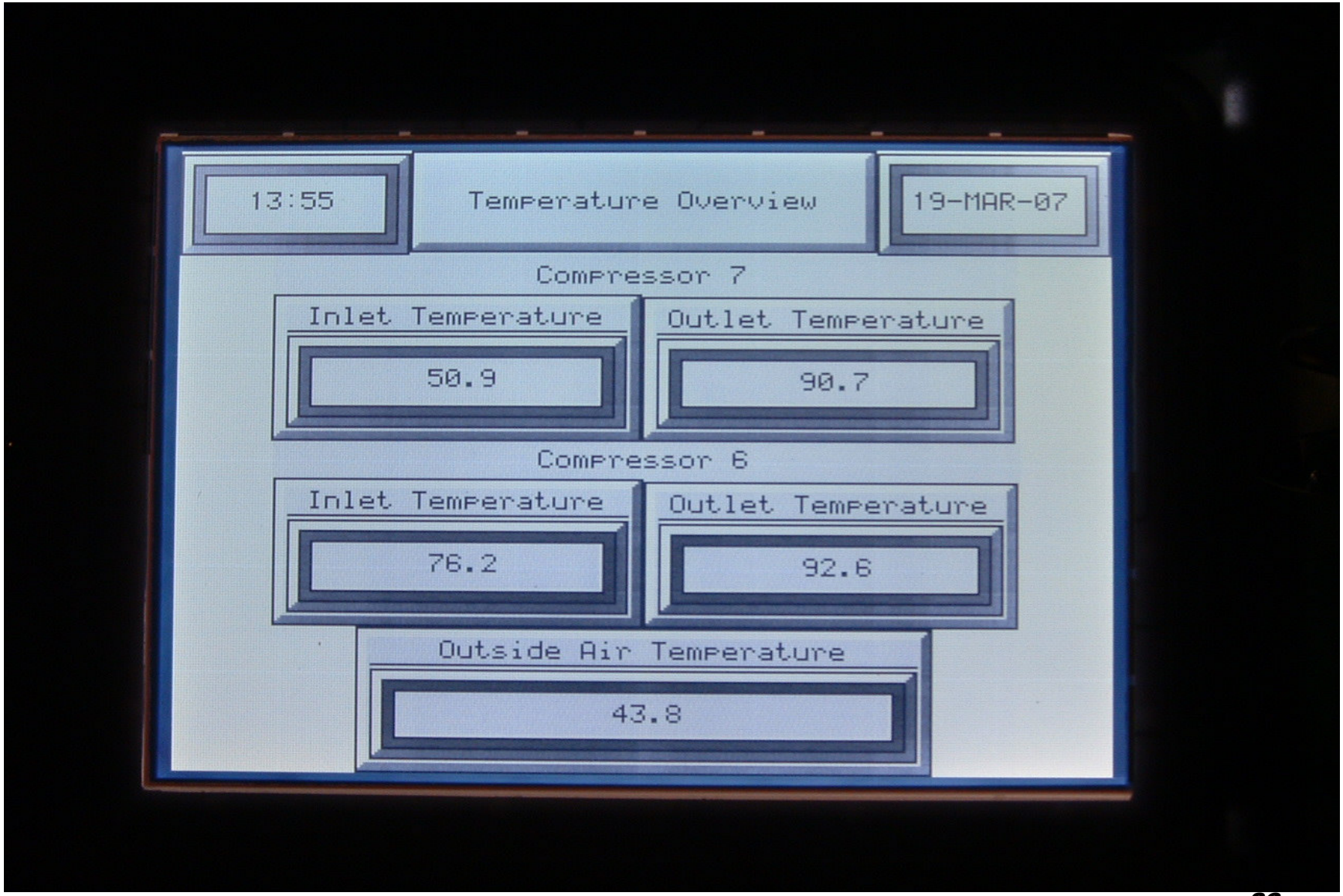
Temperature of work space the controlling factor on discharge choice.

Project Breakout

Scope: Install 2ea 200 HP Air Cooled Rotary Screw Air Compressors with Cycling Dryers, Final Filtering, 1550 Gals of air storage and Waste Heat Recovery.

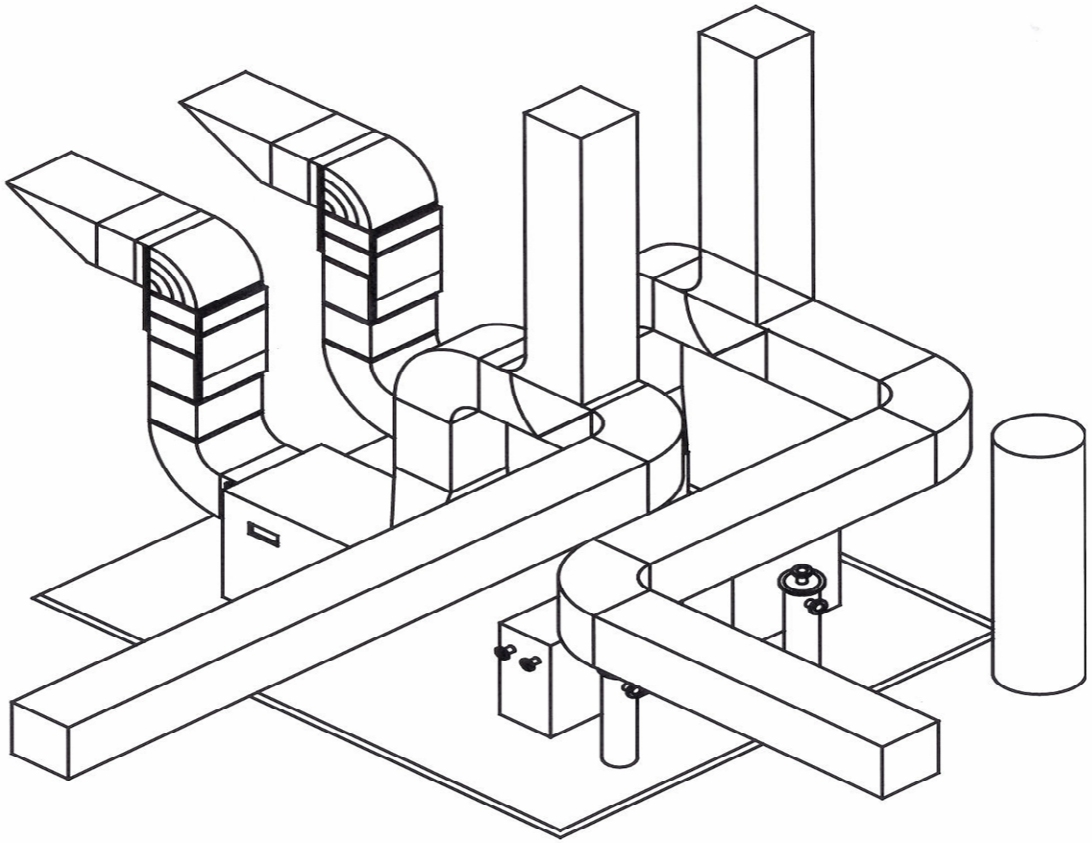
Total Project Gross Cost	**$404,600**
National Grid DSM Rebate	**$111,300**
Bay State Gas DSM Rebate	**$ 26,091**
Net Project Cost	**$267,209**

Simple Payback at $94,000/year Nat Gas Savings 2.8 Years


13:55
Temperature Overview
19-MAR-07
Compressor 7
Inlet Temperature
50.9
Outlet Temperature
90.7
Compressor 6
Inlet Temperature
76.2
Outlet Temperature
92.6
Outside Air Temperature
43.8

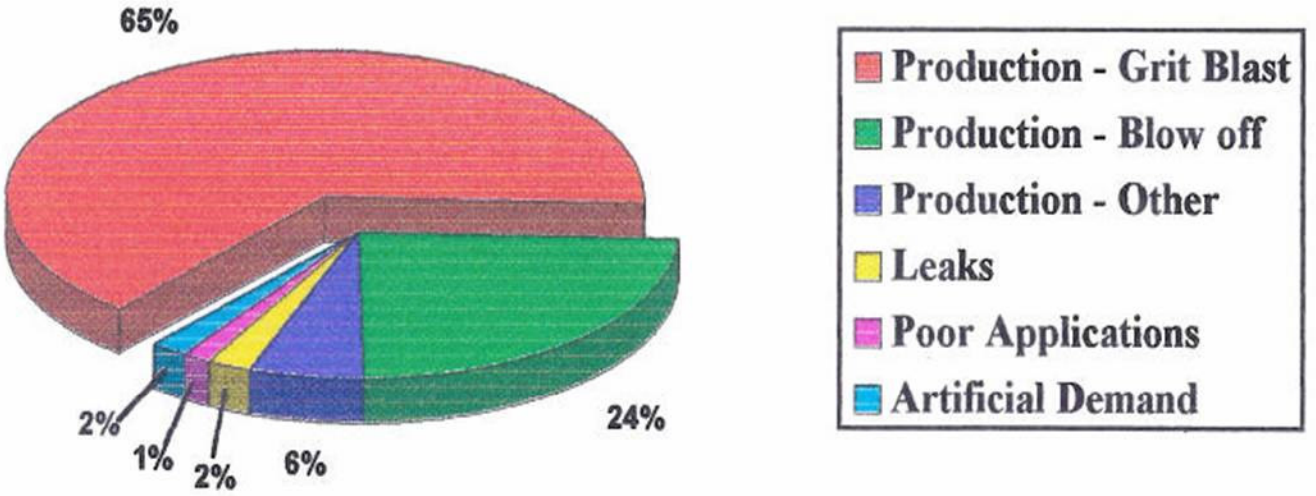

IR
Ingersoll


IR
Ingersoll-Ran



Now Where From Here?

The following pie chart shows the components of (full production) demand in your plant:



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Having addressed the many Supply Side issues;

Many Demand Side issues still exist.

- Pulse Cartridge Air Filters
- High System Pressure needs due to poor point of use Design or High Delta Ps.
- Lowering of total System Pressure.

Instituting Plant Wide Procedures to insure that new systems are properly specified and designed.

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We need to lower the 88 psig System Pressure down to 80 psig

In Conclusion:

Though this audit was specifically for compressed air, the principles and benefits of third party audits have great value across the entire energy spectrum and no matter how well we feel we know our systems these audits can show us opportunities we might otherwise miss!

This audit continues to be an excellent guide for Lenox as we continue on our constant upgrading Process.

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